GASES

QUALITY ASSURANCE PROJECT PLAN

VOLUME II

B-002-OAQ-AMB-QA-20-Q-R0

PREPARED BY:

Indiana Department of Environmental Management (IDEM)
Office of Air Quality (OAQ)
Air Monitoring Branch (AMB)
Quality Assurance Section (QAS)
Mail Code 61-54-2
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Revision 0

January 1, 2020

QAPP Revision History

Revision Number	Date	Responsible Party	Description of Change
0	January 1, 2020	QAS Chief	New QAPP format to replace QA Manual, which served as OAQ AMB QAPP, and was last U.S. EPA approved on March 9, 2018.

List of Acronyms

Acronym	Meaning
°C	Degrees Celsius
AA	Administrative Assistant
AC	Assistant Commissioner
AMB	Air Monitoring Branch
AMS	Ambient Monitoring Section
ANP	Annual Network Plan
AQI	Air Quality Index
AQS	Air Quality System
ATS	Air Toxics Section
CAA	Clean Air Act
CAPS	Cavity Attenuated Phase Shift
CBSA	Core Based Statistical Area
CFEP	Comms Front-End Processor
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSN	Chemical Speciation Network
EPA	Environmental Protection Agency
GCMS	Gas Chromatography Mass Spectrometry
GD	Guidance Documents
GMIS	Gas Manufacturer Intermediate Standard
I	Intercept
IDEM	Indiana Department of Environmental Management
INDOT	Indiana Department of Transportation
IMPROVE	Interagency Monitoring of Protected Visual Environments Network
IR	Infrared Radiation
LEADS	Leading Environmental Analysis and Display System
M	Slope
MFC	Mass Flow Controller
NAAQS	National Ambient Air Quality Standards
NCore	National Core Network
NIST	National Institute of Standards and Technology

Acronym	Meaning
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NO_y	Reactive Nitrogen Compounds
NPAP	National Performance Audit Program
NTRM	NIST Traceable Reference Material
O_2	Oxygen
O_3	Ozone
OAQ	Office of Air Quality
OPS	Office of Program Support
PAMS	Photochemical Assessment Monitoring Station
Pb	Lead
PE	Performance Evaluation
PM	Particulate Matter
$PM_{1.0}$	Particulate matter having an aerodynamic diameter less than or equal to 1.0 um
$PM_{2.5}$	Particulate matter having an aerodynamic diameter less than or equal to 2.5 um
PM_{10c}	Particulate matter having an aerodynamic diameter between 2.5 um and 10 um
PMT	Photomultiplier Tube
PQAO	Primary Quality Assurance Organization
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Section
QC	Quality Control
QMP	Quality Management Plan
REQAS	Recycling, Education and Quality Assurance Section
SD	Standard Deviation
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations
SO_2	Sulfur Dioxide
SPM	Special Purpose Monitoring
SOP	Standard Operating Procedure
SRM	Standard Reference Material
STN	Special Trends Network
TAD	Technical Assistance Documents
TAPI	Teledyne Advanced Pollution Instrumentation
TSOP	Technical Standard Operating Procedure
TTP	Through The Probe
UV	Ultraviolet
UVC	Ultraviolet Carbon
VFC	Virtual File Cabinet
VOC	Volatile Organic Compound

Section 1: QA Project Plan Identification and Approval

Indiana Department of Environmental Management (IDEM) – Office Air Quality (OAQ) – Air Monitoring Branch (AMB) – Quality Assurance Project Plan (QAPP) – Gases – Revision 0

This QAPP is designed to provide an overview of the minimum requirements for a quality assurance (QA) and quality control (QC) program for air monitoring networks which conduct gas sampling in the state of Indiana. Requiring monitoring networks to meet these criteria allows the data from all monitoring networks to be compared in a meaningful way. Gases sampled under the requirements of this QAPP include:

- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)
- Nitric Oxide (NO)
- Nitrogen Dioxide (NO_2)
- Oxides of Nitrogen (NO_x)
- Reactive Nitrogen Compounds (NO_y)
- Ozone (O_3)
- Sulfur Dioxide (SO_2)

A QC/QA program encompasses all phases of ambient air sampling and data analysis. These phases include such things as site selection, monitoring equipment selection, calibration/verification/audit equipment and procedures, sampling procedures, laboratory analysis, data verification/validation, chain of custody, data reporting, precision/accuracy reporting, and meteorological criteria. Prior to the implementation of any ambient monitoring network becoming operational, a working knowledge of this QAPP is necessary by those personnel designated as QC and QA.

There are three basic sections of the CFR Title 40, Protection of the Environment, which deal with Ambient Air Monitoring:

- 40 CFR Part 50 lists the National Primary and Secondary Ambient Air Quality Standards.
- 40 CFR Part 53 lists alternate equivalent air monitoring methods and procedures for obtaining equivalency.
- 40 CFR Part 58 gives detailed descriptions of monitoring methodology, network design and siting, Prevention of Significant Deterioration (PSD) requirements, and QA criteria.

Additional federal requirements are also given in U.S. Environmental Protection Agency (EPA) Technical Assistance Documents (TAD) and U.S. EPA QA Guidance Documents (GD). Designated QC and QA personnel should maintain a working knowledge of all applicable requirements. All monitoring and QA program requirements must be kept current and accessible.

Document Approval

Gases Quality Assurance Project Plan Volume II
Indiana Department of Environmental Management
Office of Air Quality
Air Monitoring Branch
Indianapolis, IN 46219

B-002-OAQ-AMB-QA-20-Q-R0

Approval Signatures and Date Signed:

IDEM AMB Chief	**Signature: _____ Date: _____**
IDEM AMB AMS 1 Chief	**Signature: _____ Date: _____**
IDEM AMB AMS 2 Chief	**Signature: _____ Date: _____**
IDEM AMB ATS Chief	**Signature: _____ Date: _____**
IDEM AMB QAS Chief	**Signature: _____ Date: _____**
IDEM OAQ Assistant Commissioner	**Signature: _____ Date: _____**
IDEM OPS QA Staff	**Signature: _____ Date: _____**
U.S. EPA Region 5 QA Coordinator	**Signature: _____ Date: _____**

Section 2: Table of Contents

List of Tables

Section 3: Distribution / Notification List

All members of the IDEM/OAQ play an important role in the collection, verification, validation, data analysis, assessment, planning, and reporting of air monitoring data. All entities that are part of the primary quality assurance organization (PQAO) are provided electronic copies of this QAPP and must adhere to the elements of the QAPP. Copies of the QAPP are also provided to those who conduct air monitoring in Indiana under their own PQAO. Table 1 shows how the QAPP is distributed. An official copy of the QAPP is also available on the IDEM air quality web page and the IDEM SharePoint™ QA Library.

Table 1. QAPP Distribution

Name	Organization	Phone
Air Monitoring Branch Chief	IDEM/OAQ/AMB	317-308-3264
Quality Assurance Section Chief and Staff	IDEM/OAQ/AMB/QAS	317-308-3257
Ambient Monitoring Section (1 and 2) Chief(s) and Staff	IDEM/OAQ/AMB/AMS(s)	AMS#1 317-308-3263 AMS#2 317-308-3272
Air Toxics Section Chief and Staff	IDEM/OAQ/AMB/ATS	317-308-3248
Office of Program Support Recycling, Education and Quality Assurance Section Chief	IDEM/OPS/REQAS	317-234-6562
Environmental Coordinator	Industries conducting air monitoring in Indiana	Contact QAS Chief
Environmental Coordinator	Consultants conducting air monitoring in Indiana	Contact QAS Chief
QA Manager	U.S. EPA Region 5	312-353-2325
IDEM Quality Management Staff	IDEM Office of Program Support	Contact OPS REQAS Chief

Section 4: Project/Task Organization

4.1 Personnel Roles and Responsibilities in IDEM

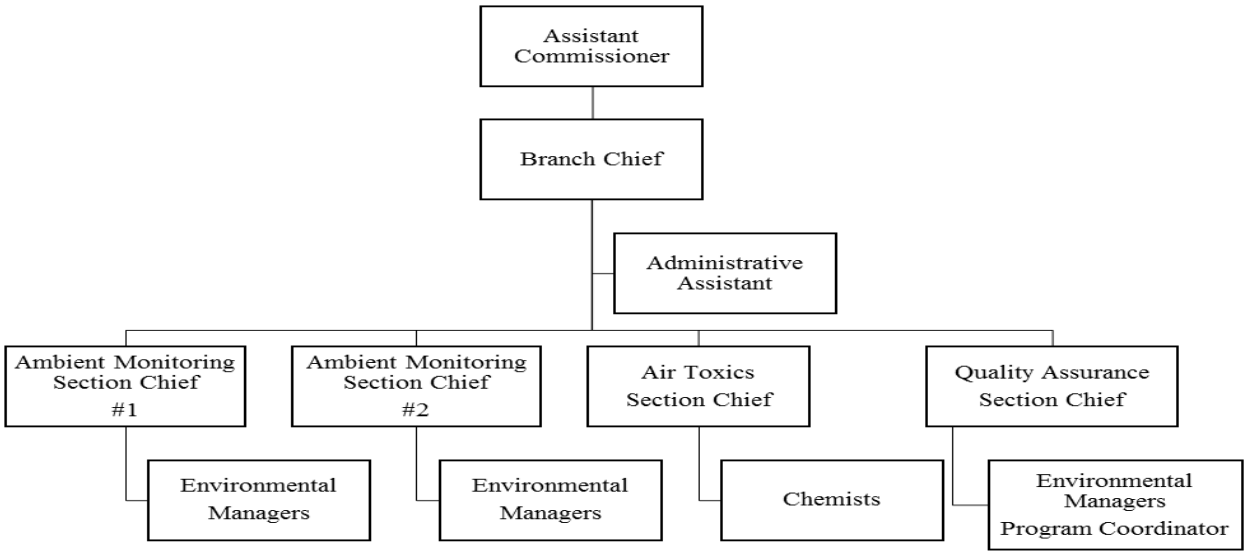
Key functions and responsibilities in IDEM are:

1. OAQ program management: Assistant Commissioner
2. AMB management: AMB Chief; AMS (1 and 2) Chief(s); ATS Chief; QAS Chief
3. Initiate equipment and supplies request: AMS (1 and 2) Environmental Managers, QAS Environmental Managers, and ATS Chemists with oversight by AMS (1 and 2) Chief(s), QAS Chief, and ATS Chief.
4. Procurement of AMB equipment and supplies: final approval by AMB Chief; tracking by

AA

5. Air monitoring site selection, maintenance, and operation which includes calibrations, verifications, span, zero, and QC checks: AMS Environmental Managers and ATS Chemists with oversight by AMS (1 and 2) Chief(s) and ATS Chief. As needed assistance for site selection and parameters by OAQ Programs Branch
6. Air monitoring data handling, review, verification, and retrieval requests: AMS Environmental Managers and ATS Chemists with oversight by AMS (1 and 2) Chief(s) and ATS Chief
7. Air monitoring network review and project grants: AMB Chief; AMS (1 and 2) Chief(s)
8. QA performance and system audits, site evaluations, data validation, and audits of data quality: QAS Environmental Managers and Program Coordinator with oversight by QAS Chief
9. QA laboratory: Designated QAS Environmental Manager oversees most of the work performed in the QA laboratory with some assistance from other QAS Environmental Managers and oversight by QAS Chief
10. QMP development/updates, QAPP/TSOP/SOP approval; TSOP/SOP agency distribution; review, authorization, and management of QA documentation (part 5 of QMP discusses documents and records): OPS
11. Programs Branch, Permits Branch, and Compliance and Enforcement Branch: utilize AMB data; see https://www.in.gov/idem/airquality/ for specific duties of these areas

4.2 AMB Organizational Chart



4.3 AMB Roles and Responsibilities

Table 2 lists general duties of the positions within the AMB. The AMS #2 has an Environmental Manager designated as the AQS administrator, whose responsibilities include data submittal into AQS. Also in the AMS #2 is an Environmental Manager designated as the LEADS administrator, whose duties include reviewing and evaluating data outputs as well as setting

limits, overseeing programming within LEADS, and coordinating specific work functions of LEADS with MeteoStar. The QAS has an Environmental Manager designated to upload one point quality control checks and QA PE audits into AQS. The environmental managers/program coordinator listed under the QAS maintain separate equipment from the AMS(s) and the ATS which ensures that an independent QA program is maintained. However, on occasion the QAS equipment may be used for a QC check but never to calibrate the site instruments. Data is also validated by the QAS once it has been verified by the AMS(s). The QAS maintains the QAPP(s) and has final decision on data validity.

Table 2. Duties of Air Monitoring Branch Positions

Position	Duties
Air Monitoring Branch Chief	Overall program management; supervises section chiefs and AA; approves the purchase of major equipment; approves QAPPs/TSOPs/SOPs; and approves annual certification of data.
Ambient Monitoring Section Chiefs	Approves and makes sure AMS staff adhere to the QAPPs/TSOPs/SOPs; oversight and direction of all ambient monitoring functions which includes calibrations, verifications, QC checks, data analysis, site location/setup/shutdown, site maintenance, and the development/update of the ANP/5-year network assessment; ensures data meets quality standards; approves annual certification of data; and supervises AMS staff.
Air Toxics Section Chief	Approves and makes sure ATS staff adhere to the QAPPs/TSOPs/SOPs; oversight and direction of all toxic functions which include laboratory and field GCMS; instrument calibration and sample analysis; ensures data meets QC standards; provides assistance for the update of the ANP/5-year network assessment; approves annual certification of data; and supervises ATS staff.

Position	Duties
Quality Assurance Section Chief	Responsible for the creation, maintenance, revisions, and adherence to the QAPPs/TSOPs/SOPs; oversight and direction of all QA functions which include PE/systems audits, meteorological audits, toxic audits, site evaluations, and operation of the QA laboratory; ensures data meets quality standards with authority to make final decision on data validity; will track the completion of corrective actions and determine the success of these actions; approves annual certification of data; and supervises QAS staff.
Ambient Monitoring Environmental Managers	Performs the daily operations that are required for the air monitoring data to be properly collected, analyzed, and verified; performs site/equipment location/setup/maintenance/shutdown and calibrations/verifications/QC checks on air monitoring field equipment; and reviews, writes, and updates TSOPs/SOPs.
Air Toxics Chemists	Performs the daily operations that are required for the air monitoring data to be properly collected, analyzed, and verified; perform site visits to conduct maintenance on air toxics monitoring equipment; and reviews, writes, and updates TSOPs/SOPs.
Quality Assurance Environmental Managers	Performs PE/systems audits, meteorological audits, toxic audits, and site evaluations; performs maintenance and calibration/certification/verification on equipment; validates data; reviews, writes, and updates QAPPs/TSOPs/SOPs; and will track the completion of corrective actions and determine the success of these actions.
Quality Assurance Program Coordinator	Assists with meteorological audits and site evaluations; distributes, tracks, and validates data; performs audits on the PM clean rooms; reviews, writes, updates; and distributes QAPP/TSOPs/SOPs; communicates QA work to AMB Chief for bi-weekly report, which includes TSOP/SOP approval/revision updates; and will track the completion of corrective actions and determine the success of these actions.
Air Monitoring Branch Administrative Assistant	Organizes the tracking and surplus of air monitoring equipment and maintains the QA documentation used to implement that monitoring program.

Section 5: Problem Definition/Background

In 1970, the Clean Air Act (CAA) was signed into law. The CAA provided the regulations and framework for the monitoring of criteria pollutants (CO, NO_2, O_3, SO_2, Pb, PM) by state, local, and tribal organizations through the establishment of an Air Quality Monitoring Program.

IDEM's mission is to implement federal and state regulations to protect human health and the environment while allowing the environmentally sound operations of industrial, agricultural, commercial and government activities vital to a prosperous economy. The mission of the OAQ is to assure all Hoosiers' ambient air quality meets the NAAQS; provide timely, quality air permits without unnecessary requirements; and to verify compliance with applicable state and federal air pollution laws and regulations. Five branches are part of the OAQ, which includes Programs, Permits, Compliance and Enforcement, Operations, and Air Monitoring. A description and a flowchart of these is available in the QMP at https://extranet.idem.in.gov/standards/docs/quality_improvement/qmps/idem_qmp_2018.pdf. The AMB is divided among four sections (See 4.2. AMB Organizational Chart, above) which includes two site monitoring sections (AMS's), an air toxics laboratory (ATS), and a quality assurance section (QAS).

This QAPP covers all of the gas parameters, as stated in Section 1. The QAPP is reviewed annually and updated if needed. Any TSOPs/SOPs associated with this QAPP are updated a minimum of every four years or if the procedures change. Air monitoring data is collected to:

- Demonstrate that the NAAQS are being met
- Develop, modify, or activate control strategies that prevent or reduce air pollution episodes
- Detect and analyze pollution trends throughout the state and/or region
- Provide a database for research and evaluation of effects

Section 6: Project/Task Description

Air quality is regulated to protect public health and the environment in the state of Indiana and has been going on for decades. This on-going requirement to collect air monitoring data is required by regulation and is used to determine compliance with the U.S. EPA's NAAQS. NAAQSs are identified for the criteria pollutants; CO, NO_2, O_3, SO_2, $PM_{2.5}$, PM_{10}, and Pb. Indiana monitors CO, NO_2, O_3, and SO_2 which have NAAQS identified for them (see table 3). Other gases in this QAPP which do not have ambient standards established for them are also monitored, which includes CO_2, NO, NO_x, and NO_y. For the gases monitored, the AMB performs all of this work in-house and currently doesn't rely on any contractual work for data results.

Measuring pollutant concentrations in outdoor air and comparing the measured concentrations to corresponding standards determines whether the ambient air quality status of an area is attaining or not attaining the standards. The NAAQS are separated into primary and secondary standards. Primary standards are those established to protect public health. Secondary standards are those established to protect the public welfare from adverse pollution effects on soils, water, vegetation, manmade materials, animals, weather, visibility, property, and economy.

The scientific criteria upon which the standards are based are reviewed periodically by the U.S. EPA, which may retain or change the standards according to its findings. Note that there are hundreds of compounds that are considered pollutants when found in ambient air but whose health and welfare effects are not well enough understood for ambient standards to be defined.

A pollutant measurement that is greater than the ambient air quality standard for its specific averaging time and level is called an exceedance. An exceedance is not necessarily a synonym for a violation. For each pollutant there are specific rules regarding the number of allowable exceedances in a given period of time. In the event the exceedances meet the NAAQS criteria to qualify as a violation, regulatory actions may result to further clean up the area's air. The distinction between one exceedance and exceedances that result in a violation is made to allow leeway in the NAAQS for exceedances caused by unusual weather patterns or unforeseen circumstances.

The design value for a site is the level of pollutant concentration when the rules of the NAAQS calculations are applied to that specific pollutant. For example, the O_3 design value is calculated by taking the annual fourth-highest daily maximum 8-hour concentration, averaged over three years. If this number is above the NAAQS, then it is a violation or 'nonattainment' of the NAAQS. If the design value is below the NAAQS then the area is in 'attainment' of the standard. Generally, nonattainment is based on the highest design value reported for a specific geographic area (usually a CBSA), and the entire area would be defined by that monitor, and classified accordingly.

Other important uses of the air monitoring data include the production of a daily AQI report, daily air quality forecast report, support of short and long-term health risk assessments, identification of a localized health concern, and tracking long-term trends in air quality.

Table 3. NAAQS

Pollutant	Primary/Secondary	Averaging Time	Level	Form
CO	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
NO_2	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and Secondary	1 year	53 ppb	Annual Mean
O_3	Primary and Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

Pollutant	Primary/Secondary	Averaging Time	Level	Form
SO2	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

6.1 Overview of Monitored Gas Parameters

IDEM presents two different types of air quality data, intermittent and continuous, on IDEM's internet website http://www.in.gov/idem/airquality/2346.htm. Monthly and annual summary reports of pollutants collected by manual methods are available as well as hourly values from continuous monitors. The LEADS provides on-line access to Indiana's continuous air quality monitoring network. It has been available to the public since July, 2007. LEADS offers access to near real-time data from approximately 60 active and historic data from approximately 12 discontinued continuous air monitoring sites across Indiana. This allows anyone to track pollutant and meteorological values throughout the day. In addition, past data back to 1998 are available as raw data and canned summary reports or user specified retrievals. Also available on LEADS is intermittent data from approximately 45 sites. Below are the different gases which are monitored.

Criteria Pollutants

Carbon Monoxide (CO)

CO is an extremely poisonous gas that is slightly less dense than the ambient atmosphere. When introduced into the bloodstream, even at low levels, CO attaches itself to the hemoglobin in the blood, seriously disrupting the delivery of oxygen to brain and body tissue, causing unconsciousness and death. The health risk is most immediate for individuals with cardiovascular disease.

Nitrogen Dioxide (NO_2)

NO_2 is a highly toxic, reddish-brown gas that is created primarily from fuel combustion in industrial sources and vehicles. It creates an odorous haze that causes eye and sinus irritation, blocks natural sunlight, and reduces visibility.

Ozone (O_3)

Ground-level O_3, or photochemical smog, is not emitted into the atmosphere as ozone, but rather is formed by the reactions of other pollutants. The primary pollutants entering into this reaction, VOCs and oxides of nitrogen (NO_x), create ozone in the presence of sunlight. Ozone is a strong irritant of the upper respiratory system and also causes damage to crops.

Sulfur Dioxide (SO_2)

SO_2 is a gaseous pollutant that is emitted primarily by industrial furnaces or power plants burning coal or oil containing sulfur. At high concentrations, breathing can be impaired. Damage

to vegetation can also result as SO_2 is dissolved in atmospheric water droplets from which it falls as acid rain.

Non-Criteria Parameters

Carbon Dioxide (CO_2)

In 2009, the U.S. EPA declared CO_2 a pollutant. CO_2 is the primary greenhouse gas emitted through human activities. Gases that trap heat in the atmosphere are called greenhouse gases. CO_2 is naturally present in the atmosphere as part of the earth's carbon cycle. The carbon cycle is the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals. CO_2 emissions come from a variety of natural sources. Human activities can influence the carbon cycle by adding more CO_2 to the atmosphere and by influencing the ability of natural sinks, like forests, to remove CO_2 from the atmosphere. The main human activity that emits CO_2 is the combustion of fossil fuels like coal, natural gas, and oil used for energy and transportation.

6.2 Project Schedule

The AMB collects and analyzes samples of gases to determine the concentrations. The gases are collected continuously using LEADS. The AMS checks on these analyzers are also performed using LEADS. Tables 4 and 5 list information outlining the specific checks performed on the gas analyzers. Specific information on the AMS checks is available in the AMB TSOP's "Gas Calibration with LEADS System", "TAPI Calibrator series 700 Setup/Maintenance", and "Nitrogen Species Calibration with LEADS System". Information pertaining to the QAS PE audit checks is available in the AMB TSOP's "Carbon Dioxide (CO2) Audit Procedures", "Carbon Monoxide Direct Cylinder Audit Procedures", "Nitrogen Dioxide Gas Phase Titration Audit Procedures", "Ozone Audit Procedures", and "Sulfur Dioxide Audit Procedures".

Table 4. AMS Checks on Gas Analyzers

Parameter	Check	Frequency
CO CO Trace	Calibration	Monthly – with no more than 6 months between two calibrations
CO CO Trace	Zero/Span	Daily Zero/Span (CO); Weekly Zero/Span (CO-Trace)
CO CO Trace	One Point QC	Weekly – with no more than 2 weeks between two QC points
CO_2	Calibration	Monthly – with no more than 6 months between two calibrations
CO_2	Zero/Span	Daily
CO_2	One Point QC	Weekly – with no more than 2 weeks between two QC points
$NO/NO_2/NO_x$ NO_2-CAPS NO/NO_y	Calibration	Every 3 months – with no more than 6 months between two calibrations

Parameter	Check	Frequency
$NO/NO_2/NO_x$ NO_2-CAPS NO/NO_y	Zero/Span	Daily Zero ($NO/NO_2/NO_x$, NO_2-CAPS); Weekly Zero (NO/NO_y); Daily Span (NO/NO_x, NO_2-CAPS); Weekly Span (NO_2, NO/NO_y)
$NO/NO_2/NO_x$ NO_2-CAPS NO/NO_y	One Point QC	Weekly – with no more than 2 weeks between two QC points
O_3	Calibration	Every 3 months – with no more than 6 months between two calibrations
O_3	Zero/Span	Daily
O_3	One Point QC	Weekly – with no more than 2 weeks between two QC points
SO_2 SO_2 Trace	Calibration	Every 3 months – with no more than 6 months between two calibrations
SO_2 SO_2 Trace	Zero/Span	Daily Zero/Span (SO_2); Weekly Zero/Span (SO_2-Trace)
SO_2 SO_2 Trace	One Point QC	Weekly – with no more than 2 weeks between two QC points

Table 5. QAS PE Audit Checks on Gas Analyzers

Parameter	Frequency
CO, CO Trace, CO_2, NO, NO_2, NO_x, NO_y, O_3, SO_2, SO_2 Trace	Quarterly; 3 year cycle for TTP where feasible.

6.3 Site Locations

Site locations are available in the IDEM/OAQ/AMB Annual Network Plan and through http://idem.tx.sutron.com/. The locations and gas parameters measured will depend on the type of monitoring network. Listed below are the different air monitoring networks where gas parameters are collected.

State and Local Air Monitoring Stations (SLAMS)

SLAMS consists of a national network of monitoring sites whose size and distribution is largely determined by the needs of state and/or local air pollution authorities.

Special Purpose Monitoring (SPM)

SPM sites are designed/intended for use by state and local agencies to collect supportive data for development of State Implementation Plans (SIPs) and/or other specific targeted studies such as: point source identification, control strategy effectiveness, etc. If data is used for SIP purposes, SPM sites must meet all federal and state requirements for monitoring methodology and quality assurance.

National Core Network/Photochemical Assessment Monitoring Station (NCore/PAMS) Monitoring

NCore is a nationwide, multi-pollutant approach to monitoring. NCore sites are intended to support multiple objectives with a greater emphasis on assessment, research support, and accountability than the traditional SLAMS networks. NCore provides an opportunity to address new directions in monitoring and begin to fill measurement and technological gaps that have accumulated in the networks. Indiana operates one urban NCore site. These sites are required to measure $PM_{2.5}$, speciated $PM_{2.5}$, PM_{10c}, O_3, SO_2, CO, NO, true NO_2, NO_y, and meteorology. As of June 2021 PAMS is included at NCore sites located in a CBSA with a population of 1,000,000 or more.

Near-Road Monitoring

On February 9, 2010, the U.S. EPA promulgated monitoring regulations for the NO_2 monitoring network. In the new monitoring requirements, state and local air monitoring agencies are required to install near-road NO_2 monitoring stations at locations where peak hourly NO_2 concentrations are expected to occur within the near-road environment in larger urban areas. Site selection is required to consider traffic volumes, fleet mix, roadway design, traffic congestion patterns, local terrain, and meteorology in determining where a required near-road NO_2 monitor should be placed. Indiana operates one near-road monitoring site. IDEM worked with the INDOT to obtain a location for the site. The near-road site is required to measure NO, NO_2, CO, O_3, and meteorology. Toxics VOC's and particulates, such as $PM_{2.5}$, $PM_{1.0}$, and continuous speciation (black carbon/UVC) are also measured at this site.

Chemical Speciation Network (CSN)

As part of the $PM_{2.5}$ NAAQS review completed in 1997, the U.S. EPA established a $PM_{2.5}$ CSN consisting of Special Trends Network (STN) sites and supplemental speciation sites. The CSN is a component of the National $PM_{2.5}$ Monitoring Network. The goal of the National $PM_{2.5}$ Monitoring Network is to monitor if the NAAQS are being attained. However, CSN data is not used for attainment or nonattainment decisions, but are intended to complement the activities of the larger gravimetric $PM_{2.5}$ measurement network component. CSN data is used for multiple objectives, including:

- The assessment of data trends;
- The development of effective SIPs and determination of regulatory compliance;
- The development of emission control strategies and tracking progress of control programs;
- Aiding in the interpretation of health studies by linking effects to $PM_{2.5}$ constituents;
- Characterizing annual and seasonal spatial variation of aerosols; and
- Comparison to chemical speciation data collected from IMPROVE network.

Section 7: Quality Objectives and Criteria for Measurement Data

The primary data quality objective, which is adopted from those established by the U.S. EPA, is to ensure that the data collected by the AMB are consistent, of known and adequate quality,

supported by adequate calibrations and evaluations, and sufficiently complete to describe the atmospheric state with respect to spatial and temporal distribution. Minimum QA requirements are listed in 40 CFR part 58 and its appendices. The data must meet the quality goals for representativeness, precision, bias, detectability, completeness, and comparability. Accuracy has been a term frequently used to represent closeness to "truth" and includes a combination of precision and bias error components. This term had been used throughout the CFR but has been replaced with bias when there is the ability to distinguish precision from bias. The quality system for the AMB air monitoring program focuses on understanding and controlling, as much as possible, measurement uncertainty and because of that, mainly focuses on precision, bias, detectability, completeness, and comparability. Representativeness is addressed through network designs and is not something that the quality system can control through better measurements.

Collecting quality data begins with properly trained staff and adequate funding to provide the necessary equipment that meets the required performance specifications. High quality data also relies on having adequate supplies available, safe monitoring locations that meet U.S. EPA siting requirements, up-to-date QAPP(s), and TSOPs/SOPs.

Table 6 lists the objectives and how the AMB approaches each one.

Table 6. Objective/Approach

Objective	Approach
Representativeness	The data collected will represent ambient air that the public is exposed to. Monitoring locations are selected to meet this objective and adhere to U.S. EPA requirements for siting. All sample inlets must be the proper height above the ground, and have a minimum distance from objects that could affect the representativeness of the results of the data collected as described in 40 CFR part 58 Appendix E. Special purpose monitoring, Near-Roadway monitoring, and industrial-based monitoring have different siting requirements designed to meet these special monitoring objectives. Examples of siting include: - Minimum of 10 meters from the dripline of trees - Distance from sampler to any obstruction must be twice the height that the obstruction protrudes above the sampler Inlet height 2 to 15 meters above ground except for CO microscale, which is 2.5 to 3.5 meters above ground
Precision	Precision for gas samplers is estimated from one point quality control checks.

Objective	Approach
Bias	Bias for gas samplers is estimated from one point quality control checks.
Detectability	The determination of the low range critical value of a characteristic that a method specific procedure can reliably discern. Maximum limits also apply. For the AMB gases program, U.S. EPA MDL's are adopted.
Completeness	The AMB strives to obtain the highest level of data capture or completeness as possible. Data completeness is defined as the number of valid measurements (meeting all QC and QA criteria) divided by the number of possible or scheduled measurements. All data must meet a minimum of 75% completeness.
Comparability	Ambient air monitoring is conducted in adherence to the established methods as published in 40 CFR Part 50 and 53 for national consistency and comparability. Participation in the National Performance Audit Program (NPAP), Ambient Air Protocol Gas Verification Program, as well as conference calls help ensure comparability. In addition, those who operate under their own PQAO in Indiana and submit air monitoring data into AQS will be subject to an annual evaluation by the QAS.

7.1 Measurement Quality Objectives

To ensure the quality of the data, sampler calibrations, spans, zeroes, and one point QC checks are performed by the AMS. These are performed on a set schedule automatically programmed into LEADS. Additional calibrations, spans, zeroes, and one point QC checks can be manually programmed by AMS parameter specialists when the analyzer fails its warning limit or when there is concern on the accuracy of the data collection. Any failed check will not report data values starting from the last passing check until a new check passes. Although this data is initially flagged, it may be shown to be valid afterwards, which the parameter specialist can edit. All of these checks help determine the validity of the data by ensuring that the analyzers meet specific limits. The LEADS also has additional checks, such as linearity and precision, which must meet specific limits to pass. All analyzers require a calibration after maintenance which can affect the output of the analyzer. Additional PE audits are performed independently by QAS. The QA results provide statistical analysis of the data and determine the accuracy of the data. There are some instances where the QAS will run a one point QC concentration, usually when AMS has equipment issues or additional information is needed on the data. The QAS also performs zero air audits annually. Tables 7 and 8 list the types of checks as well as the limits. Additional information as well as calculations are provided in the AMB TSOPs listed in section 6.2 of this QAPP as well as the AMB TSOP "Zero Air Generator System Verifications and Audits".

Table 7. AMS Methods Data Assessment Requirements

Type of Check: Calibration, span, zero, and one point QC		
Parameter Method	**Assessment Method**	**Measured Quality Objectives**
CO	Analyzer response to standard gas for calibration on 0-20 ppm range (CO trace at 0-5 ppm range); span at 70-90% of full range; zero; one point QC check at 0.5-5.0 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±10.1%; zero warning at ±0.4 ppm and failure at ±0.6 ppm; Precision < 10.1%; Bias < ±10.1%; Span/one point QC warning at ±8.0%
CO_2	Analyzer response to standard gas for calibration on 0-1000 ppm range; span at 70-90% of full range; zero; one point QC check at 160-200 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±10.1%; zero warning at ±8.0 ppm and failure at ±10.0 ppm; Precision < 10.1%; Bias <±10.1%; Span/one point QC warning at ±8.0%
$NO/NO_2/NO_x$	Analyzer response to standard gas for calibration on 0-0.5 ppm range (CAPS NO_2 is 0-0.2 ppm range); span at 70-90% of full range; zero; one point QC check for NO_2 at .005-0.08 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±10.1%; zero warning at ±3.0 ppb and failure at ±5.0 ppb; Precision < 15.1%; Bias <±10.1%; Span warning at ±8.0% and one point QC warning at ±10.0%
NO/NO_y	Analyzer response to standard gas for calibration on 0-0.2 ppm range; span at 70-90% of full range; zero; one point QC check for NO_y at .005-0.08 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±10.1%; zero warning at ±3.0 ppb and failure at ±5.0 ppb; Precision < 10.1%; Bias < ±10.1%; Span/one point QC warning at ±8.0%

Parameter Method	**Assessment Method**	**Measured Quality Objectives**
O_3	Analyzer response to standard gas for calibration on 0-0.2 ppm range; span at 70-90% of full range; zero; one point QC check at .005-0.08 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±7.1%; zero warning at ±3.0 ppb and failure at ±5.0 ppb; Precision < 7.1%; Bias < ±7.1%; Span/one point QC warning at ±5.0%
SO_2	Analyzer response to standard gas for calibration on 0-0.2 ppm range (SO2 trace range 0-0.1 ppm); span at 70-90% of full range; zero; one point QC check at .005-0.08 ppm	Calibration points < ±2.1% and slope warning at ±5.0% and failure at ±7.0% of perfect slope; Span must be < ±10.1%; zero warning at ±3.0 ppb and failure at ±5.0 ppb; Precision < 10.1%; Bias < ±10.1%; Span/one point QC warning at ±8.0%

Table 8. QAS Methods Data Assessment Requirements

Type of Check: PE Audit		
Parameter Method	**Assessment Method**	**Measured Quality Objectives**
CO	Analyzer response at 0.900-2.999, 3.000-7.999, 8.000-15.999 ppm; CO trace checks at 0.060-0.199, 0.900-2.999, 3.000-7.999 ppm	Percent difference of audit levels 3-10 <±15.1%; Audit levels 1&2 <±0.31 ppm difference or <±15.1%
CO_2	Analyzer response at approximately 750, 600, and 200 ppm	Percent difference of audit levels <±15.1%
$NO/NO_2/NO_x/NO_y$	Analyzer response for NO_2 at 0.0030-0.0049, 0.0200-0.0499, 0.1000-0.2999 ppm; NO_y at 0.0003-0.0029, 0.0080-0.0199, 0.1000-0.2999 ppm	Percent difference of audit levels 3-10 <±15.1%; Audit levels 1&2 <±1.5 ppb difference or <±15.1%
O_3	Analyzer response at 0.006-0.019, 0.040-0.069, 0.090-0.119 ppm	Percent difference of audit levels 3-10 <±15.1%; Audit levels 1&2 <±1.5 ppb difference or <±15.1%

Parameter Method	Assessment Method	Measured Quality Objectives
SO_2	Analyzer response at 0.0030-0.0049, 0.0050-0.0079, 0.0500-0.0999 ppm; SO_2 trace checks at 0.0003-0.0029, 0.0030-0.0049, 0.0500-0.0999 ppm	Percent difference of audit levels 3-10 <±15.1%; Audit levels 1&2 <±1.5 ppb difference or <±15.1%
Zero Air	Zero check	CO/CO Trace = readings <100.0 ppb, absolute difference between site zero air and QA zero air <50.5 ppb; $NO/NO_2/NO_x/O_3/SO_2$ = readings <1.0 ppb, absolute difference between site zero air and QA zero air <1.5 ppb; NO_2 at NCORE = readings <0.50 ppb, absolute difference between site zero air and QA zero air <0.505 ppb; SO_2 Trace = readings <0.200 ppb, absolute difference between site zero air and QA zero air <0.2005 ppb

Note: QA Audit levels can be found at https://aqs.epa.gov/aqsweb/documents/codetables/audit_levels.html

The QAS chief will confirm what levels to use for the upcoming year by using previous year's data. In most instances these audit levels will remain the same.

7.2 NPAP Audits

Gas analyzer bias is determined from the results of independent national performance audit program (NPAP) audits. The U.S. EPA Region 5 or their designated contractor performs these audits. Requirements for NPAP audits are detailed in 40 CFR Part 58 Appendix A Section 3.1.3 and other posted NPAP implementation GD's. Results of audit samples are reported to AQS by the U.S. EPA Region 5 or the designated contractor.

7.3 Sampler Through the Probe (TTP) audits

The QAS will perform TTP audits on each gas analyzer on a 3 year cycle, where feasible. This TTP audit will be reported as a PE audit. These results will help determine the accuracy of the data collected from the probe inlet through the full sample path.

Section 8: Training

Formal staff training is scheduled to train new employees and periodically update employees' skills and program operations. Formal staff training is coordinated with the Section Chiefs, senior level staff, or parameter specialists of the AMS, QAS, and ATS of the AMB on an as needed basis for those person(s) engaged in the following: operating, calibrating, verifying,

validating, and auditing analyzers/samplers; laboratory procedures; field duties; safety; and any other items related to work performed by staff in the AMB. The training for staff is tracked and documented by the individual section chiefs, except for any in-house training pertaining to computer safety, which is documented by the IDEM computer staff but able to be tracked by individual section chiefs. Standard literature references are readily available to all staff members including the Federal Register, manufacturer's instrument manuals, and QA GD's related to the program objectives. Courses and other training are also provided through U.S. EPA and vendors.

Section 9: Documentation and Records

The goal of IDEM is to collect data that is accurate and representative of the actual conditions. For this to occur, documentation and record keeping have to be performed at a high level of accuracy and be consistent amongst all participants who are part of the PQAO. The AMB shared drive is only available to AMB staff which helps secure any tampering issues. Documents on the extranet can only be seen by IDEM staff. Documents on the extranet and internet can only be changed by the IDEM computer staff. Documentation in LEADS is secure and cannot be changed once entered. Data in LEADS can be changed only by AMS(s) Chiefs and staff. This procedure is provided in the AMB TSOP "Gaseous Data Validation Using LEADS". The QA laboratory cabinet is located in a secure location with limited access to others. Table 9 summarizes what documentation is involved, location of these documents, retention time, and the main custodian. All records are either kept at the minimum requirements as addressed in the IDEM QMP, or kept indefinitely.

Table 9. Documentation and Records

Document	Location	Retention Time	Custodian
ANP; 5 Year Network Plan; QAPP	IDEM internet and extranet; AMB shared drive	Latest on IDEM internet and extranet; AMB shared drive maintains previous versions	ANP and 5 Year Network Plan – AMS (1 and 2) Chief(s); QAPP – QAS Chief
TSOPs/SOPs	IDEM extranet; AMB shared drive	Latest on extranet; AMB shared drive maintains previous TSOPs/SOPs	QAS Program Coordinator and OPS
Logs	Electronic log available through LEADS	Kept indefinitely	AMS Environmental Manager LEADS Administrator
CO, CO_2, $NO/NO_2/NO_x/NO_y$, O_3, SO_2 audit forms	AMB shared drive	Kept indefinitely	QAS Environmental Manager
Data, calibration, span, zero, one point QC check	LEADS	LEADS maintains data indefinitely	AMS Environmental Manager LEADS Administrator

Document	Location	Retention Time	Custodian
AMS exceedance reports	AMB shared drive	Kept indefinitely	AMS Environmental Manager
QAS data memos; data checks; exceedance reports; and site evaluations	AMB shared drive; VFC; site evaluation record also on LEADS	Kept indefinitely	QAS Chief and Program Coordinator
Calibrations, certifications, and verifications performed by the QA laboratory	AMB shared drive	Information kept at least 3 years unless item is still in circulation then information is kept indefinitely	QA Laboratory Manager
NIST-traceable certifications	QA laboratory cabinet file	Kept indefinitely	QA Laboratory Manager

Section 10: Network Description (or Sampling Process Design)

Gas sampling is primarily conducted in population centers per U.S. EPA requirements. Additional sites are also operated to establish rural background concentrations, provide statewide as well as regional coverage, and for areas of specific interest, such as sources and near road. The IDEM ANP provides information on sites and can be found at https://www.in.gov/idem/airquality/2389.htm

Network design and sampler siting is established based on 40 CFR Part 58, Appendices D and E, and is mentioned in Sections 6 and 7 of this QAPP.

Section 11: Sampling Method Requirements

Sampling equipment and procedures follow 40 CFR Part 50, Appendices A, C, D, and F. Specific instructions on technical aspects of these procedures can be found in the equipment manual for each analyzer as well as the following AMB TSOPs; “Gas Calibration with LEADS System”, “Running Field Loop”, “TAPI Calibrator series 700 Setup/Maintenance”, “LEADS Install Site Procedures”, “Continuous Air Monitoring Site Setup”, “Continuous Air Monitoring Station (CAMS) Shelter Maintenance”, “Nitrogen Species Calibration with LEADS System”, “Oxides of Carbon Monitor Annual Preventative Maintenance”, “Teledyne Cavity Attenuated Phase Shift (CAPS) Model T500U NO2 Analyzer Maintenance and Troubleshooting”, “Thermo Scientific 42i Chemiluminescence NO-NO2-NOX Analyzer Maintenance”, “Sulfur Dioxide (SO2) Analyzer Maintenance” and “Teledyne API 200EU 501Y NO-NOY Analyzer Maintenance”. The AMB maintains a complete set of TSOPs/SOPs for all procedures, which is

available through the AMB shared computer drive and the IDEM website, https://extranet.idem.in.gov/main.php?section=standards&page=sops.

11.1 Sampling Equipment

The AMB utilizes continuous analyzers that meet established federal reference method or equivalent method requirements except for some gas sampling designated as non-criteria (see table 10). Documentation of changing out instrumentation or a method change at a site is made in the site LEADs program.

Table 10. Gas Sampling Equipment

Parameter	Reference Method	Monitor Type
CO CO Trace	Automated Reference Method: RFCA-1093-093	TAPI T300 TAPI T300U
CO_2	No Federal Reference Method	TAPI T360
$NO/NO_2/NO_x$	Automated Reference Method: RFNA-1289-074	Thermo Scientific 42i
NO_2	Automated Equivalent Method: EQNA-0514-212	TAPI T500U
NO/NO_y	Automated Reference Method: RFNA-1194-099	TAPI T200U
O_3	Automated Equivalent Method: EQOA-0992-087	TAPI T400
O_3	Automated Equivalent Method: EQOA-0880-047	Thermo Scientific 49C Thermo Scientific 49i
SO_2 SO_2 Trace	Automated Equivalent Method: EQSA-0486-060	Thermo Scientific 43i Thermo Scientific 43iQ Thermo Scientific 43i-TLE

11.2 Sampling Methodology

Below is a summary on the method of how each gas is analyzed. Specific concepts and procedures are provided in the instrument's operating manual.

11.2.1 Gases

- CO – CO absorbs infrared radiation (IR) at known frequencies. When IR passes through a sample cell, the CO absorbs a portion of the IR. This measurement method compares the amount of IR passing through the sample cell with the amount of IR passing through a CO free reference cell. Next, the method converts this difference in IR absorption passing through the two cells to an output signal.

- CO_2 – CO_2 absorbs IR at known frequencies. When IR passes through a sample cell, the CO_2 absorbs a portion of the IR. This measurement method compares the amount of IR passing through the sample cell with the amount of IR passing through a CO_2 free reference cell.

Next, the method converts this difference in IR absorption passing through the two cells to an output signal.

- $NO/NO_2/NO_x$ – The chemiluminescence measurement method is based on the reaction of O_3 with NO to form NO_2 and O_2. The excited state NO_2 emits infrared light with an intensity proportional to the NO concentration. A chemiluminescent method NO_2 analyzer indirectly determines concentrations of NO_2 by measuring NO and NO_X concentrations. NO_x is defined as the sum of the NO_2 and NO analyzer measurements. The analyzer never directly measures the native NO_2 in ambient air. The analyzer utilizes a switching solenoid to direct the ambient air through two processes.

  In one process, the analyzer oxidizes the incoming ambient air sample with O_3. The interaction of O_3 and NO produces electronically excited NO_2 molecules, but does not excite the existing NO_2 molecules. The excited NO_2 molecules immediately decay to a lower energy level by emitting infrared light (chemiluminescence) in the 600 nm to 2400 nm wavelength range. The intensity of the light generated is directly proportional to the concentration of NO in the ambient air sample.

  The second process sends the ambient air through a catalytic converter. Any NO_2 in the air sample is reduced by the converter to NO. The NO already in the air sample is not affected by the converter. The reduced NO_2 and NO is then oxidized with O_3 to produce the electronically excited (light emitting-chemiluminescent) NO_2 molecule. The intensity of light is measured by the analyzer and is reported as the NO_x concentration. The analyzer derives the concentration of NO_2 by subtracting the NO concentration from the NO_x concentration.

- NO_2 – The Cavity Attenuated Phase Shift (CAPS) NO_2 monitor operates as an optical absorption spectrometer yielding direct measurements of ambient nitrogen dioxide down to sub ppb concentrations. The CAPS method uses light from a blue ultraviolet light emitting diode centered at 450 nm, a measurement cell with high reflectivity mirrors located at both ends to provide an extensive optical path length, and a vacuum photodiode detector. These components are assembled within an optical cell which resides in a temperature controlled oven. The oven raises the ambient temperature of the sample gas to 45°C to reduce the formation of moisture on the surfaces of the mirrors, while also minimizing changes in the absorption coefficient due to temperature fluctuations. The CAPS method measures NO_2 directly, using optical absorption, a phenomenon that is well-defined by Beer's Law, where the absorbance is directly proportional to both the path-length and concentration of the absorbing gas.

- NO/NO_y – NO_y has been identified as precursors for the formation of both O_3 and $PM_{2.5}$. NO_y consists of all oxides of nitrogen in which the oxidation state of the nitrogen atom is +2 or greater. NO_Y refers to the sum of all reactive nitrogen oxides including NO_x (NO + NO_2) and other nitrogen oxides referred to as NO_z. The major components of NO_z include nitric acid (HNO_3), nitrous acid (HONO), organic nitrates [peroxyl acetyl nitrate (PAN), methyl peroxyl acetyl nitrate (MPAN), and peroxyl propionyl nitrate, (PPN)], and particulate nitrates. The

same principle used for the measurement of NO, NO_2, and NO_x is used for the total reactive oxides measurement. The NO and NO_y concentrations are determined by photochemically measuring the light intensity at wavelengths greater than 600 nanometers from the chemiluminescent reaction of NO with O_3. To measure NO_y, sample air is passed through a probe-mounted catalytic converter. The nitroxyl compounds present are reduced to NO. The NO already in the air sample is not affected by the converter.

The NO resulting from the reduction of these nitroxyl compounds, plus any native NO is directed to a reaction chamber to react with O_3. The intensity of the resulting chemiluminescent light is measured as the total NO_y concentration. To measure NO separately and specifically, sample air by-passes the catalytic converter so that no reduction of the nitroxyl compounds to NO occurs. This procedure is similar to the methodology used to measure NO_x; however, it uses a higher converter temperature to more completely convert NO_z species, and the converter is moved near to the sample inlet to avoid line losses of "sticky" NO_y species, such as HNO_3.

- O_3 – The method used to monitor O_3 is based on the Beer-Lambert principle that O_3 absorbs ultraviolet light. The greatest absorbance takes place at the 253.7 nm wavelength. A low pressure mercury vapor lamp produces light at this wavelength. This light is admitted into a measuring cell. Ozonated (sample) air and nonozonated (zero) air are alternately passed through the sample cell. The UV radiation passes through the sample and is absorbed by ozone. The strength of the UV signal detected, after passing through the sample air, is directly proportional to the O_3 concentration.

- SO_2 – The pulsed fluorescence method of measuring ambient levels of SO_2 involves the reaction of SO_2 with UV light. Sample air passes through a catalyst that conditions the sample by scrubbing out aromatic hydrocarbons. The air sample is drawn into the sample reaction cell in which the fluorescent measurement takes place. The UV excitation of SO_2 in the air sample creates a fluorescent light output proportional to the SO_2 concentration. A PMT measures the fluorescent light output. The current output of the PMT is processed by an electrometer amplifier that sends a voltage to the analyzer output terminals. This voltage may be adjusted to correspond to SO_2 concentrations in the reaction cell.

11.2.2 Shelter Temperature Requirements

Gas analyzers, calibrators, and zero air systems are located in a shelter, whether it be an IDEM air monitoring trailer or a room located inside a building. The analyzers, calibrators, and zero air systems are required to operate under specific temperatures. Table 11 lists the temperature range required for each type of equipment for data collected to be valid. The standard deviation limit is to provide temperature stability information and is not necessarily an indication of a temperature infraction resulting in invalid data. Also listed in table 11 are the temperature limits for audit equipment used by the QAS.

Table 11. Gas Analyzer, Calibrator, Zero Air System Indoor Temperature Requirements

Item	Make/Model	Temperature Range
CO analyzer	TAPI T300	10.0 – 40.0°C; < 2.1°C SD over 24 hours
CO Trace analyzer	TAPI T300U	10.0 – 40.0°C; < 2.1°C SD over 24 hours
CO_2 analyzer	TAPI T360	10.0 – 40.0ºC; < 2.1°C SD over 24 hours
$NO/NO_2/NO_x$ analyzer	Thermo 42i	15.0 – 35.0ºC; < 2.1°C SD over 24 hours
NO/NO_y analyzer	TAPI T200U	20.0 – 30.0ºC; < 2.1°C SD over 24 hours
NO_2 analyzer	TAPI T500U	5.0 – 40.0ºC; < 2.1°C SD over 24 hours
O_3 analyzer	Thermo 49C Thermo 49i	5.0 – 40.0ºC; < 2.1°C SD over 24 hours
SO_2 analyzer	Thermo 43C Thermo 43i Thermo 43iQ	20.0 – 30.0ºC except Thermo 43iQ which is 0.0 – 45.0ºC; < 2.1°C SD over 24 hours
SO_2 Trace analyzer	Thermo 43i-TLE	20.0 – 30.0ºC; < 2.1°C SD over 24 hours
Calibrator	Environics 6103	15.0 – 30.0°C
Calibrator	ESC 7700P	5.0 – 43.0°C
Calibrator	Sabio 2010	5.0 – 40.0°C
Calibrator	Sabio 4010	5.0 – 40.0°C
Calibrator	Tanabyte 724	5.0 – 40.0°C
Calibrator	TAPI T703U	5.0 – 40.0°C
Calibrator	TAPI T700U	5.0 – 40.0°C
Calibrator	Thermo 49i-PS	0.0 – 45.0ºC
Zero Air System	CSI 205	15.0 – 35.0°C
Zero Air System	EESI 2000	4.4 – 65.6°C
Zero Air System	Perma Pure	-20.0 – 40.0°C
Zero Air System	Sabio 2020	10.0 – 30.0°C
Zero Air System	TAPI 701	5.0 – 40.0°C
Zero Air System	TAPI 751H	5.0 – 40.0°C

11.3 Failed Sample Events

In the event of a malfunctioning analyzer that was not collecting data according to specific requirements, the AMS will provide information into the LEADS, giving detailed information why the data is invalid or if a QA qualifier needs added. If the QAS finds an issue, then a memo will be sent to the AMS, who will then confirm the results. A detailed log is also entered in LEADS by the QAS for the specific site.

Section 12: Sample Handling and Custody

12.1 Sample Handing

Measurements of all the continuous gases are collected year round. All gas analyzer digital outputs are connected to a Sutron data logger. This data is downloaded every 10 minutes via broadband by LEADS. LEADS ingests, integrates, processes, preliminarily quality controls, stores, and provides visualization of the data. The data is provided to the public within one hour

of collection. The data goes through extensive QC analysis then it is provided to the QAS, which does its own post processing checks. Data is uploaded into AQS within 90 days after the end of each quarter. Certification of all data for the previous calendar year is completed by May of the current year.

12.2 Sample Custody

The AMB strives to collect high quality data that is accurate, defensible, and representative of an area's ambient air. Sample integrity is maintained in two ways. First, the security of the air monitoring site helps to ensure that the analyzers are not tampered with which would compromise the data. Sites are either located in a dedicated shelter in a locked fenced area or if in a building, in a locked room with limited access. Data loggers including laptop computers require a password to gain access. Secondly, all of the sites maintain an electronic log book. Any staff who visits the site for any reason is to state the purpose of their visit and leave information detailing the work performed at the site. Log entries also are entered on templates, which ensures consistency.

12.3 Photographs and Digital Still Images

When photographs or digital images are taken for purposes of documenting and to support a field investigation, such as a QAS site evaluation, then a record of each exposure or image will be saved as a file on an AMB shared drive on the computer. The following information will be recorded:

- The site name and what it shows will be part of the file's name, which will be stored based on the year it was taken. For example, file name "Gary IITRI SE" stored under the path QA\Site Information\Site Photos\Gary IITRI\2020.
- The name of the individual who took the photograph or digital image will correspond to any paperwork, such as a site's evaluation. If no paperwork is used, a log entry on LEADS is adequate.

12.4 Equipment Documentation

Any equipment used in the gases program to perform calibrations, spans, zeroes, QC checks, and audits will have documentation kept on it. A certification file will be kept for each item and stored in the QA laboratory and on the AMB shared drive.

Section 13: Analytical Methods

For gas parameters, the monitoring methods are "self-contained" within the apparatus (analyzer) utilized and no additional analyses at a laboratory are required.

Section 14: Quality Control Requirements

Field sampling quality control and acceptance criteria is detailed in Section 7.1 of this QAPP. Limits for spans, zeroes, and one point QC checks are calculated within LEADs. The QAS and NPAP audit results are calculated independently of LEADS. TSOPs/SOPs describe these

procedures and are mentioned throughout this QAPP, are available on the AMB shared computer drive, and also listed at the IDEM website, https://extranet.idem.in.gov/main.php?section=standards&page=sops. Table 12 lists the action taken when results do not meet measured quality objectives.

Table 12. Measured Quality Objective Checks and Outcomes

Check	Outcome
AMS Calibration Frequency	If more than 6 months have passed, data will be assigned a QA qualifier "1" until a calibration is performed if spans/zeros/One Point QC checks indicate accurate data. If additional checks are not available or there is evidence of inaccurate data, data is invalid after 6 months until a new calibration is performed. Data is replaced with an "EC" null data qualifier.
AMS Calibration Results	If a calibration fails, further review of the data and the condition of the site calibrator and zero air system may result in a QA qualifier, a null data qualifier, or void the calibration. Data collection moving forward may use the previous passing calibration slope and intercept until a new passing calibration occurs (see AMS calibration frequency above if the next passing calibration goes beyond 6 months).
AMS Zero Frequency	If a zero check has been missed, the condition of the data will be evaluated, which may include reviewing the next zero air check, one point QC check, PE audit, data comparison among sites, and the gas trace. Any suspicion of the condition of the data may require a QA qualifier or a null data qualifier.
AMS Zero Results	If a zero check fails, further review of the data and the condition of the site calibrator and zero air system may result in a QA qualifier, a null data qualifier, or void the zero air check.
AMS Span Frequency	If a span check has been missed, the condition of the data will be evaluated, which may include reviewing the next span, one point QC check, PE audit, data comparison among sites, and the gas trace. Any suspicion of the condition of the data may require a QA qualifier or a null data qualifier.
AMS Span Results	If a span check fails, further review of the data and the condition of the site calibrator and zero air system may result in a QA qualifier, a null data qualifier, or void the span check.

Check	Outcome
AMS One Point QC Frequency	If a one point QC check is missed in a 2 week period, data may be assigned a QA qualifier "1" if other checks indicate accurate data. Any indication of an issue may warrant a null data qualifier on the data starting from the last passed span or one point QC check up to a new passing span or one point QC point.
AMS One Point QC Results	If a one point QC check fails, data is invalid using appropriate null data qualifier back to last passing span or one point QC check, unless there is sufficient evidence to indicate otherwise. If a one point QC check is in error, then it will be replaced with a null date qualifier "1C".
LEADS internal checks for stability and precision	Any failure of these will void a check.
QAS Audit Frequency	If an audit is missed in a quarter, then the next audit will occur as scheduled for the following quarter. Additional audits may be performed based on maintenance being performed on AMS equipment to improve results or for troubleshooting.
QAS Auditor Results	If QAS audit results do not meet specifications, data is suspect. The AMS must follow up with a check, such as a span, zero, one point QC check, and if needed a calibration. Condition of the data will be determined after further review of additional checks.
NPAP Audit	If NPAP results do not meet specifications, data is suspect from the last calibration of the analyzer up to the issue being resolved. The AMS must follow up with some action, such as maintenance, one point QC check, etc. QAS may provide assistance.

Section 15: Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Analyzers, calibrators, zero air systems and any other items that are part of the data collection process (this includes anywhere the sample gas comes into contact) must have checks and routine preventive maintenance performed to ensure proper operation. Most manufacturers supply a preventive maintenance checklist with the instruction manual. A specific schedule is shown in table 13. When new equipment arrives, it is checked prior to field use to ensure all diagnostics meet manufacturer specifications. The manufacturer normally provides its own form showing the QC checks it had performed prior to sending out the equipment. All checks and maintenance must be documented in the site logbook, LEADS, or any forms used as part of the check. The AMS parameter specialist is informed of any issues. Any impact to data will be determined on a case by case basis unless it is outlined in this QAPP or in the TSOP "Gaseous Data Validation Using LEADS". All procedures on how to do the diagnostic checks as well as identify any equipment deficiencies are outlined in the instruments manuals. In cases where equipment does not meet specifications, the AMB maintains enough spare units ready for use.

Critical spare parts are also maintained to ensure data collection is able to continue. Critical spare parts may include items as part of routine checks, such as analyzer filters, or parts that may degrade over time, such as an ozone lamp.

Table 13. Checks and Preventive Maintenance

Item	Inspection Frequency	Action Required
Particulate filter	Every 3rd week per AMS loop schedule	Change and document; all gases 5 micron pore size except CO and CO_2 which are 0.5
Analyzer diagnostics	Every 3rd week per AMS loop schedule	Document flow, lamp intensities, etc.
Fan filter	Every 3rd week per AMS loop schedule	If dirty, clean dust from fan filter and document
Span cylinder	Every 3rd week per AMS loop schedule; during QAS audit	Record amount of gas left in cylinder (should be greater than 200 psig)
Calibrator	Every 3rd week per AMS loop schedule; during QAS audit	Record verification date; MFC's due annually; O_3 due 6 months
Zero air system	Every 3rd week per AMS loop schedule; during QAS audit	Record maintenance date; due annually
Fittings and connections – all stainless steel or Teflon	As needed by AMS; during QAS audit	Visually inspect for any issues, e.g. loose connections, and document
Sample line - Teflon FEP or equivalent	As needed by AMS; during QAS audit	Change out line every 1 to 4 years unless issues occur; document findings or if changed
Manifold and probe – borosilicate glass, Teflon, or equivalent	Every 3rd week per AMS loop schedule; during QAS audit; vacuum check during QAS site evaluations	Document any issues, such as cracked, dirty, open port. Vacuum ≤ 1.0 inch water below ambient; AMS cleans annually
Residence time	AMS site setup; initial QAS site evaluation and then 3 year cycle afterwards, or if changes made at site that can impact time	Determine time; must be <20.0 seconds

Section 16: Instrument Calibration and Frequency

All gas analyzers in the air monitoring network adhere to the prescribed calibration schedules that are defined in the sampling methods of 40 CFR Parts 50, 53, and 58, and the Quality Assurance Handbook for Measurement Systems Vol. II. TSOPs/SOPs generated by the AMB, such those mentioned in section 6.2 of this QAPP, and what is stated throughout this QAPP provide the specific details on the calibration procedures, time frames, and limits. All gas

calibration results are used to calculate a slope and intercept and meet the limits as stated in section 7.1 of this QAPP. The slope and intercept are used with the analyzer response to calculate a concentration. The calculated slope and intercept are used until a new calibration is performed. Any maintenance which manipulates the data output of the analyzer will require a new calibration. A slope and intercept may be used with the analyzer response prior to a calibration if it is shown the analyzer was operating under stable, normal conditions. However, to ensure accuracy of the concentrations generated, the time frame of the slope and intercept being back calculated will be based on review of span, zero, One Point QC, QA checks, trace review, operator logs, and any other information available. Data in question may be replaced with a Null Data Qualifier or be assigned a QA Qualifier.

Transfer standards used for this work also follow strict verification/certification/calibration schedules for valid data collection to occur. Almost all transfer standards are verified/certified/calibrated against standards that are maintained at the QA laboratory. If the QA laboratory cannot do the work, then the item is sent to a standards laboratory. On occasion some items are sent to a standards laboratory to cross check the transfer standards used in the QA laboratory. All equipment is verified/certified/calibrated prior to use. Table 14 lists the transfer standards used in the gases program. Table 15 lists specific O_3 requirements, with additional information available in the AMB TSOP "Ozone (O3) Transfer Standard Verification Procedures". Work performed with an expired calibrator date is voided.

Table 14. Instrument Calibration/Certification and Frequency

Type of Device	Frequency	Primary Standard	Limits / Comments
Gas Calibrator MFC used for calibration, span, one point QC, and zero checks	12 months	QA laboratory Fluke Molbox1+	±1.0%; see AMB TSOP "Certification of Mass Flow Meters Using the Fluke molboxTM/molbloc-sTM System".
Gas Calibrator O_3 Photometer used for calibration, span, one point QC, and zero air checks	6 months	QA laboratory Level 2 – Indiana Primary Standard Photometer	See table 15.
Zero Air System used for CO, CO_2, NO, NO_2, NO_x, NO_y, O_3, and SO_2 zero air checks	12 months; except 6 months for O_3 calibrators that produce their own zero air	QA laboratory clean air system	See table 8, QAS zero air check.

Type of Device	Frequency	Primary Standard	Limits / Comments
1 to 50 ppm SO_2 in Nitrogen Gas Cylinder used for calibration, span, and one point QC checks	4 years	QA laboratory SRM, NTRM, or GMIS gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4.0% of previous certified concentration; see AMB TSOP "Sulfur Dioxide Transfer Standard Certification Procedures".
1 ppm to 15% CO in Nitrogen Gas Cylinder used for calibration, span, and one point QC checks	8 years	QA laboratory SRM, NTRM, or GMIS gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4.0% of previous certified concentration; see AMB TSOP "Carbon Monoxide Transfer Standard Certification Procedures".
0.5 to 50 ppm NO in Nitrogen Gas Cylinder used for calibration, span, and one point QC checks	3 years	QA laboratory SRM, NTRM, or GMIS Gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4.0% of previous certified concentration; see AMB TSOP "Nitric Oxide (NO) Transfer Standard Certification Procedures".
5 ppm to 20% CO2 in Nitrogen EPA Protocol Gas Cylinder used for calibration, span, one point QC checks, and PE audits	8 years	Cylinder Company SRM, NTRM, or GMIS Gas cylinder	Cylinder certified according to the 2012 EPA Traceability Protocol, Document #EPA-600/R-12/531, using Procedure G1.

Type of Device	Frequency	Primary Standard	Limits / Comments
Gas Calibrator MFC used for PE audits	6 months	QA laboratory Cal Technix, Molbox	±1.0%; see AMB TSOP "Certification of Mass Flow Meters Using the Fluke molboxTM/molbloc-sTM System".
Gas Calibrator O_3 Photometer used for PE audits	Quarterly	QA laboratory Level 2 – Indiana Primary Standard Photometer	See table 15.
1 ppm to 15% CO in Nitrogen Gas Cylinder used for PE audits	6 months	QA laboratory SRM, NTRM, or GMIS Gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4% of previous certified concentration; see AMB TSOP "Carbon Monoxide Transfer Standard Certification Procedures".
500 ppb to 10% CO in Air Gas Cylinder used for PE audits	8 years	QA laboratory SRM, NTRM, or GMIS gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4% of previous certified concentration; see AMB TSOP "Carbon Monoxide Transfer Standard Certification Procedures".
0.5 to 50 ppm NO in Nitrogen Gas Cylinder used for PE audits	6 months	QA laboratory SRM, NTRM, or GMIS gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4% of previous certified concentration; see AMB TSOP "Nitric Oxide (NO) Transfer Standard Certification Procedures".

Type of Device	Frequency	Primary Standard	Limits / Comments
1 to 50 ppm SO2 in Nitrogen Gas Cylinder used for PE audits	6 months	QA laboratory SRM, NTRM, or GMIS gas cylinder	All calculated concentrations must be ≤±4.0% of the average concentration. The difference between any two calculated concentrations must be ≤5.0%. New concentration ≤±4.0% of previous certified concentration; see AMB TSOP "Sulfur Dioxide Transfer Standard Certification Procedures".

Table 15: Ozone Certification Requirements

Criteria	Limit	Comment
1-day Slope	0.975 to 1.025 (or ±2.5% of 1.000)	NA
1-day Intercept	±5 ppb (±0.005 ppm).	NA
Std Dev (S_m) of Average Slope $\overline{m}$ (expressed as a percentage)	$S_m \leq 3.7\%$	The standard deviation of the average of 6 slopes. Calculated from either the initial 6-day certification or the 1-day recertification.
Std Dev (S_I) of Average Intercept $\bar{I}$ (expressed as a percentage)	$(S_I) \leq 1.5\%$	The standard deviation of the average of 6 intercepts. Calculated from either the initial 6-day certification or the 1-day recertification.
Slope of 1-day recertification (m)	M ±5%	1-day recertification slope must be ≤±5.0% of the average slope of the current 6-day certification.

Section 17: Inspection/Acceptance Requirements for Supplies and Consumables

Analyzer and calibrator replacement parts are obtained from the manufacturer or a distributor when the items are commonly available and needed by the AMB. The parameter specialist for the AMS and the ATS keeps track of their own supplies and will order items when needed. The QA laboratory manager makes sure the QA laboratory has enough supplies and QA field staff also keep track of when items are needed. A designated QA environmental manager will order supplies for the QAS when needed. Most consumables do not have an expiration date. If there is an expiration date the AMS and ATS parameters specialist and the QA laboratory manager will track and dispose of it when it expires. Gas cylinders used for the gases mentioned in this QAPP are purchased for the AMS and the QAS by a designated AMS environmental manager when needed, with usually several always available for use between orders. Gas cylinders are certified

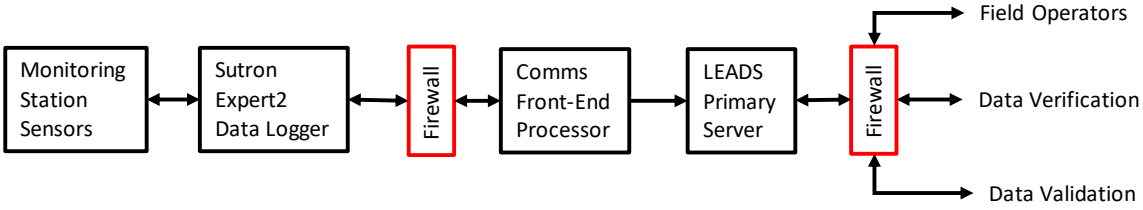
by the QA laboratory, except CO_2 which is NIST-traceable factory certified, and tracked by both the AMS and QAS. Paperwork is kept with the cylinders which shows when the cylinder certification expires. The cylinder documentation is kept in the QA laboratory and managed by the QA laboratory manager.

Section 18: Non-direct Measurements

IDEM uses all of its own generated gas concentrations to determine design values and determine if an area meets the NAAQS (see 40 CFR Part 50). Some site selection and data analysis can be based upon pollutant data generated by other entities as well as the use of meteorological data obtained from the National Weather Service and traffic counts by INDOT. The additional data used for site selection and data analysis is viewed as being accurate since this data falls under specific rules and guidelines.

Section 19: Data Management

Minimizing data loss is of paramount importance to each monitoring program in order to meet and exceed the program's data completeness requirements. Data loss can result from missing or invalid data. Data records are generated through the use of LEADS. It is the goal of IDEM to collect 100% of generated data and maintain a completeness rate of at least 75% valid data. The U.S. EPA requires at least 75% of data to be valid to meet completeness requirements. The processes of determining valid data and the QC/QA of these processes is mentioned in this QAPP. The data process includes collecting, storing, transmitting, verifying, validating, and reporting to the U.S. EPA's AQS database.



The data process starting from the field to AQS submittal consists of the following steps:

1. Data collection is performed using an approved U.S. EPA reference analyzer.
2. Each site has a specific IP address and each parameter has its own internal IP address. Data is sent from the analyzer via digital output to a router with a Sutron Expert2 data logger hooked in-line. Although data collection is continuous, data is averaged in five minute intervals. The Sutron data logger is capable of storing up to approximately two weeks of data before it starts being overwritten. The Sutron data logger at the site requires a password to access it.
3. The LEADS Comms Front-End Processor (CFEP) at MeteoStar in Round Rock, Texas communicates with the data loggers and retrieves data from them every 10 minutes through the internet via cellular modem. The MeteoStar LEADS software collects data from the data logger using the Native Datalogger Computer-To-Computer language (CC-

SAIL). Preliminary data checks are performed and then the data is forwarded to the LEADS server. The CFEP computers can store three months of data.

4. A LEADS server housed at MeteoStar in Round Rock, Texas polls data from the CFEP computers. The data is decoded, checked for errors, processed and stored in a database. The LEADS database uses a flat, packed binary structure and are physically segregated by date and monitoring site. Each binary data file contains all the measurements from a monitoring site for a specific day. The binary data files are kept indefinitely by MeteoStar. The binary files are backed up on a second server in Colorado. The original data files can also be reloaded if a need arises, such as accidental deletion of processed numbers or bogus slope, intercept, offset applied to data.
5. The LEADS software performs automatic quality checks during span/zero checks (SPZ), span/1-point QC/zero checks (SPN) and calibrations (CAL). The results of the automatic quality checks can result in data flagging, affecting data validity.
6. Each business day, the AMS LEADS Administrator will check the monitoring data database to ensure that all data were polled and transmitted successfully from each monitoring station and stored on LEADS. In case of missing data, a re-poll can be initiated to backfill the data.
7. Approximately 1 to 3 weeks after the end of a month, AMS staff will initiate the data verification procedure. AMS staff log into the LEADS server and are able to review and flag raw data and document data verification by using a program within LEADS called ManVal. (Note: LEADS recognizes this process as “data validation” although it is the verification process). A log is made in ManVal which documents who verified the data, changes made, and a date/time when this occurred (see AMB TSOP “Gaseous Data Validation Using LEADS”).
8. Once the data has been verified, AMS staff will inform the QAS program coordinator via e-mail that verified data is ready for validation.
9. The QAS program coordinator logs the date that the verified data has been sent to the QAS and then informs QAS environmental manager via e-mail that data is ready for validation. The QAS environmental manager has 15 business days to complete the validation process. Any exceedance review is performed within 15 days after the validation process is completed.
10. The QAS environmental manager logs into the LEADS server (read access only) and performs an audit on the data (validation process) using the various LEADS reports and the ManVal program (see Leading Environmental Analysis and Display System (LEADS) Validated Data Review Procedures”). The validation process is documented on a Validation Check form, which is stored on the Branch shared drive.
11. If data issues arise during the validation process, the issues are sent to the appropriate AMS staff member for correction or additional information.
12. Once the validation review is complete, the QAS environmental manager will initial and date the Validation Check form. The QAS environmental manager informs the QAS program coordinator via e-mail that the data validation is complete.
13. The QAS program coordinator will log the data validation completion date and informs the AMS AQS administrator via email that the data review process is completed by the

QAS.

14. The AMS AQS administrator submits the validated data to AQS.
15. Once all data for a quarter has been verified and validated, a designated environmental manager in the QAS submits one point quality control checks and QA PE audits into AQS.
16. Each quarter AMP reports are submitted by a QAS environmental manager to the QAS chief and these are reviewed for accuracy and any issues. Any indication of a problem will require further analysis by QAS and/or AMS of the reported data with the possibility of data resubmission.
17. Each year data from the previous year is certified as being true and accurate. The AMB chief, AMS (1 and 2) chiefs, TAS chief, QAS chief, and specific staff in the AMS (1 and 2) and QAS do a final check on this data package, which is then submitted to U.S. EPA.

Annually, the AMS will verify each data logger's voltage which uses analog against an NIST certified power supply. For sites which use digital, 25% of those sites have the raw data from the Sutron logger compared with the five minute and hourly analog values downloaded from the analyzer. Both of these procedures help ensure an accurate collection of data by testing the acceptability of the hardware and software configurations.

Quarterly verified and validated data is submitted to the AQS within 90 days after the quarter is complete. Data consists of ambient concentrations, one point QC checks, and PE audits. Ambient data is made available to the IDEM website as it is being collected; therefore the data has not initially had QC or QA checks performed. Data is also provided to AIRNOW as it is being collected.

Data generated by the QAS during PE audits or One Point QC checks is entered into a spreadsheet; that file is saved as a portable document format (pdf) file and then stored to the AMB shared computer drive. In addition, the audit data is entered into the U.S. EPA QA Transaction Generator to create a text file, which is submitted to AQS quarterly.

Section 20: Assessments and Response Actions

Every monitoring project includes periodic assessments in order to provide continuing verification that the project is being performed according to the procedures developed in the QAPP, and that the data obtained meet the measurement quality and overall monitoring project objectives. This section details the assessments that will be performed, the personnel responsible, the frequency and the reports produced, as well as corrective actions taken based on the results of each assessment. IDEM utilizes several assessment procedures to identify and correct issues. The corrective action process must either include formal communications (e.g., official memoranda) or informal communications (e.g., e-mail messaging) and with responses provided as formal or informal communications. Verbal communication can be used to initiate the corrective action or acknowledge completion of the corrective action, but must be followed up with written communication for documentation purposes (see table 16 for a list of assessments). In any situation, it is the AMB goal to continue to collect valid data; however, there could be some instances where outside factors jeopardize the project, resulting in some data not being collected.

The AMB does what it can to maintain continuous data collection as stated in this QAPP and will look for any possible solution to resolve issues.

Table 16. Assessments and Response Actions

Assessment	Conducted By	Frequency	Goals
Zero/Span	AMS	Daily or weekly	QAPP Requirements
One Point QC	AMS	Weekly	QAPP Requirements
PE Audit	QAS	Quarterly	QAPP Requirements
Data Verification	AMS	Monthly	Screening of data, chart trace, QC checks
Data Validation	QAS	Monthly	Screening of data, chart trace, QC and QA checks
High Value Event	QAS	As needed	Screening of information, such as calibration, zero, span, one point QC, chart trace, etc. which may impact high value
Ambient Air Protocol Gas Verification Program	U.S. EPA	CO, NO, and SO2 cylinder sent on a 3 year cycle	U.S EPA Program Requirements
AMP Reports	QAS	Quarterly	Review data for statistical issues and completeness
QAPP	QAS	Annually	Determine if changes are needed which accurately describes the project
ANP	AMB	Annually	Determine if sites cover necessary air monitoring requirements
Annual Data Certification	AMB	Annually	Review data for issues
Siting	QAS	3 years per site	QAPP Requirements
5 Year Network Assessment	AMB	5 years	Determine future monitoring goals and direction
NPAP	U.S. EPA Regional Personnel/Contractor	See Section 7.2 of this QAPP	See Section 7.2 of this QAPP
Technical Systems Audit	U.S. EPA Regional Personnel	3 years	CFR Requirements

In the event that an assessment identifies an area of concern, there are specific corrective actions which occur depending on what the finding shows. Below is listed the assessment and corrective action time frame for follow-up.

Zero/Span – Every business day, the AMS LEADS Administrator reviews the daily span/zero (SPZ) checks for possible issues. The appropriate AMS parameter specialist also has the responsibility to review the daily SPZ checks for issues. The appropriate AMS staff member addresses the issue once they are aware. QAS environmental manager verifies that action was taken and the issue resolved during the data validation process.

One Point QC – Every business day, the AMS LEADS Administrator reviews any scheduled span/1-point QC check/zero (SPN) checks for possible issues. The appropriate AMS parameter specialist has the responsibility to review the weekly SPN checks for issues. The appropriate AMS staff member addresses issues once they are aware. QAS environmental manager verifies that action was taken and the issue resolved during the data validation procedure. QAS chief also verifies QC checks every few weeks.

PE Audit – The QAS is set up as an independent section within the AMB and as such performs internal PE audits using equipment (gas calibrators, zero air generators, and compressed gas cylinders) that are independent of CAL/SPZ/SPN equipment used by the AMS. PE audits are scheduled by a QAS environmental manager on a quarterly basis. QAS staff members notify the AMS parameter specialist of any issues either from site or once back in the office with written notification (memorandum or e-mail) following soon after. Once the issue is resolved, the AMS parameter specialist must document the issue resolution.

Data Verification Process – The AMS parameter specialist performs a verification of the ambient data within 1 to 3 weeks after the end of a month. Documentation of the process can be found in the LEADS validator notes.

Data Validation Process – A QAS staff member performs a validation review of the data within 15 working days after the QA Program Coordinator is informed that a data package is available for review. Data validation is documented on the Data Check Sheet, which are stored on the AMB shared drive.

High Value Event – A QAS staff member performs additional reviews on any high values which meet or exceed the NAAQS for that parameter. This review is performed within 15 working days after the data validation is completed for that specific site and month. The high value event is documented on a data sheet, which is stored on the AMB shared drive.

Ambient Air Protocol Gas Verification Program – Corrective action taken immediately by QAS for any actions identified by the Ambient Air Protocol Gas Verification Program.
AMP Reports – Quarterly AMP Reports (AMP256, AMP430) are sent to the QAS chief after the 1-point QC checks and PE audit results are submitted to AQS within 90 days after the end of the quarter. The QAS chief and an environmental manager may consult with AMS to resolve any

issues once any are discovered. If practical, the issue should be resolved within two weeks after identification of the issue.

QAPP – QAS section chief ensures QAPP is being followed and makes necessary changes, with approval by AMB chief, AMS (1 and 2) chiefs, and ATS chief. An annual check is documented or when a change needs to be made.

ANP – The Annual Network Plan is due to the U.S. EPA Regional Administrator by July 1st. The AMB tries to have a complete ANP available for public comment by mid-May to allow for the 30-day public comment period to be completed by mid-June. Corrective actions taken immediately (based on issue could be one day but prior to New Year) by AMB based on U.S. EPA feedback.

Annual Data Certification – The Annual Data Certification for ambient data from the previous year (January 1 – December 31) is due to the U.S. EPA Regional Administrator by May 1st of each year. The AMB reviews the annual data package and resolves any correctable issues, if practical, prior to submission of the certification package.

Siting – The QAS performs site evaluations on a 3-year cycle from the previous site evaluation. The AMS addresses issues based on QAS findings (usually within a work day if data is impacted or some time frames may be extended based on the nature of the issue and if the site is on private property). QAS chief ensures corrective action is taken to resolve the issues.

5 Year Network Assessment – The 5-year Network Assessment is due at U.S. EPA by July 1st for years ending in zero or five. Corrective actions by AMB based on U.S. EPA feedback within the time frame allotted for the response.

NPAP – QAS chief works with AMS to address failing NPAP results issues as soon as possible (usually within a week to resolve any issues).

Technical Systems Audit – Technical System Audits are scheduled by the U.S. EPA Regions on a 3-year frequency. The QAS works with AMS(s) and ATS to address any audit findings. All findings should be resolved within 1 year of the TSA report.

Section 21: Reports to Management

Reports that are generated and utilized in the gases program are listed in table 17.

Table 17. Reports to Management

Report	Frequency	Responsible Party
Daily O_3 Update	As needed for high O_3 values	AMS
O_3 Exceedance Report	Monthly	AMS
AMP Reports	Quarterly	QAS
CO, NO_2, O_3, SO_2 Exceedance Reports	As needed	QAS

Report	Frequency	Responsible Party
Invalid Data Memos	As needed	AMB
Annual Network Plan	Annual	AMB
5 Year Network Plan	5 Years	AMB

Section 22: Data Validation and Usability

Many of the criteria used to review and validate data have been detailed in the previous sections of this QAPP. The AMB utilizes this established QAPP, TSOPs/SOPs, and U.S. EPA Validation Template found in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program", to determine data validity.

Section 23: Validation and Verification Methods

Data verification is the process of evaluating the completeness, correctness and conformance of a specific data set against the method, procedural or contractual requirements, as specified in both the TSOPs/SOPs and 40 CFR Part 58. Data validation is a process that extends the evaluation of data beyond method, procedural or contractual compliance (i.e. data verification) to ensure that reported values meet the quality goals of the environmental data operations and that the data can be used for its intended purpose.

The AMB uses the criteria gas pollutant validation templates provided in Appendix D of the U.S. EPA QA Handbook for Air Pollution Measurement Systems: Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-17-001, January 2017) for the weight of evidence approach for validating criteria gas data. The AMB follows the guidance in the QA Handbook regarding the use of these templates and handles the criteria as follows:

- Critical criteria are issues deemed critical to maintaining the integrity of the hourly ambient concentration measurement or a group of successive hourly ambient concentration measurements. Data reviewers should invalidate observations that do not meet each and every criterion in the critical criteria table unless there are compelling reasons and justification for not doing so. Basically, the hourly measurement or group of hourly measurements that do not meet one or more of these criteria is invalid unless proven otherwise. In most cases, the CFR dictates the requirement, the implementation frequency of the criteria and the acceptance criteria so these criteria are considered regulatory in nature.
- Operational criteria are situations where violations of a criterion or criteria may be cause for invalidation of the data. Data reviewers should consider other QC information that may or may not indicate the data are acceptable for the parameter they want to control. Therefore, ambient data, which do not meet one or more of these criteria, are suspect unless other QC information demonstrates otherwise and the reviewers have adequate documentation of that information. Data reviewers should investigate, mitigate or justify the reason for not meeting the criteria.

- Systematic criteria include those criteria, including the DQOs, which are important for the correct interpretation of the data, but do not usually impact the validity of the ambient data. If the data do not meet the DQOs, this does not invalidate any of the hourly measurements, but it may impact the confidence in the attainment/non-attainment decision.

The AMB brackets all gas concentration data using the results of the one-point QC checks, calibration, or performance evaluation audit to ensure the gas analyzers were in proper operating condition between the checks. When a monitor fails a check (CAL/SPN/SPZ), the LEADS software automatically flags the data as LIM from the last passing 1-point-QC check to time & date when the issue causing failure is remedied. The AMS parameter specialist will review the data, determine the cause for the failure and verify the extent of the data invalidation period. During the validation process, the QAS will review the invalid data period to ensure it is proper, accurate, and documented.

23.1 LEADS Data Review

As data is being collected in LEADS, there are several automatic checks that the LEADS software performs, such as a calibration, span, zero, one point QC checks, and stability issues. Dramatic shifts in data can also be recognized by LEADS, which will then flag the data until the AMS parameter specialist can do a further review. The LEADS software acquires 5-minutes concentration averages from the instantaneous concentrations generated by the gas analyzers. LEADS applies a series of automatic tests to check the validity of calibrations (CAL), span/1-point QC checks/zero (SPN), and span/zero (SPZ) checks. Depending on the outcome of the automatic tests, LEADS may initially flag the check as PASSED, WARNING, FAILED, INVALID, or INCOMPLETE (See LEADS Manual for information on the types of automatic tests and the check results). A FAILED check will result in flagging affected data with a LEADS LIM code. LEADS will flag missing data with the LEADS LOST code if it cannot repoll the SUTRON data logger to download the missing data.

23.2 AMS Verification

The LEADS administrator reviews the LEADS reports every business day to check for anomalies and to repoll data loggers when missing data is notated. In addition the LEADS administrator will review any FAILED CAL, SPN, or SPZ check and notify the AMS parameter specialist of the issue. The LEADS administrator will review the hourly values for any NAAQS exceedances and notify the AMS parameter specialist and the QAS.

After a month of data is collected, a monthly pollutant concentration report is generated by LEADS. The AMS verifies all data per the AMB TSOP “Gaseous Data Validation Using LEADS” during the monthly data review. The monthly report is reviewed by the AMS parameter specialist for data values as well as any flags applied by LEADS. These are reviewed using the LEADS operator to justify the application of the flag and to determine if they are accurately applied. The data trace is also evaluated. Any changes needed are applied by the AMS parameter specialist. Once this process is completed the AMS parameter specialist leaves a “Validator Note” in LEADS, which means the data has been verified. Once the verification process is

completed by the AMS, the QAS program coordinator is informed by the AMS parameter specialist that the data is ready for QA.

The following null and data qualifiers are available in LEADS to flag data as appropriate:

Flag Text	Description	EPA Qualifier	
		Null Data	Data Qualifier
ZERO	Neg Value Detected - Zero Reported		9
AMB-A	High Winds		A
AMB-B	Stratospheric Ozone Intrusion		B
AMB-C	Volcanic Eruption		C
AMB-D	Sandblasting		D
AMB-E	Forest Fire		E
AMB-F	Structural Fire		F
AMB-G	High Pollen Count		G
AMB-H	Chemical Spill or Industrial Accident		H
AMB-I	Unusual Traffic Congestion		I
AMB-J	Construction/Demolition		J
AMB-K	Agricultural Tilling		K
AMB-L	Highway Construction		L
AMB-M	Rerouting of Traffic		M
AMB-N	Sanding/Salting of Streets		N
AMB-O	Infrequent Large Gatherings		O
AMB-P	Roofing Operations		P
AMB-R	Cleanup After Major Disaster		R
n	Not used	AA	
TEMP	Shelter Temperature Outside Limits - 9971 - AE	AE	
FEW	Insufficient Data - 9975 - AI	AI	
VOID	Voided by Operator - 9978 - AL	AL	
NEG	Failed NEG Test - 9979 - AM	AM	
MUL	Failed MUL Test - 9979 - AM	AM	
BLAN	Blank Sample	AM	
AUDI	Audit Sample	AM	
5PPB	5 ppb-V Unblended Standard Check	AM	
EXP	Experimental or Bad Sample	AM	
RT S	Standard Sample	AM	

ARC	GC Acetylene Response Check	AM	
CACS	GC Compress Air Comp Sample	AM	
DCSD	GC Daily Cal Check Stand Dup	AM	
DLA	GC Detection Limit Analysis	AM	
RAS	GC Radian Audit Sample	AM	
UNK	GC Unknown Flag in File	AM	
NOD	Not Detected	AM	
LIM	Failed Limit Check - 9980 - AN	AN	
MAL	Machine Malfunction - 9980 - AN	AN	
ICE	Bad Weather - 9981 - AO	AO	
LOST	Lost - 9983 - AQ	AQ	
POOR	Poor Quality Assurance Results - 9985 - AS	AS	
ADJ	Instrument Adjustment - Cal - Background Zero - 9986- AT	AT	
NOL	Not On Line - 9987 - AU	AU	
POW	Power Failure - 9988 - AV	AV	
SPZ	Span-Zero Check - 9991 - AY	AY	
VER	QC Verification - 9992 - AZ	AZ	
PM	Preventive Maintenance - 9993 - BA	BA	
CAL	Multi-Point Calibration - 9995 - BC	BC	
SPN	Span Check - 9998 - BF	BF	
OPE	Operator Error - 9963 - BJ	BJ	
DAS	Data Logger not communicating with instrument - 9962 - BK	BK	
QAS	QA Audit in Progress - 9961 - BL	BL	
BAL	Negative values under AQS Acceptable Limits - BR	BR	
ALNR	Above Linear Range - EH		EH
AMB-IF	Fire - Canadian Informational - IF		IF
AMB-IH	Fireworks Informational - IH		IH
AMB-IM	Prescribed Burning - IM		IM
AMB-IT	Wildfires - US		IT
BDL	Below Detection Limit		MD
AMB-RH	Fireworks RH		RH

Additional flags are available to be applied as well. These can be found at https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html.

23.3 QAS Validation

The QAS validates the data per the following AMB TSOP "Leading Environmental Analysis and Display System (LEADS) Validated Data Review Procedures". The QAS program coordinator sends an e-mail to the QAS staff member who is responsible for performing the validation on that specific data. A standard form is used by QAS, which includes analysis of concentrations as well as a review of QC and QA processes and to document the review.

When high concentrations are identified, whether by email or memo by the AMS or ATS, the QAS is notified of the site and date/time when the exceedance occurred. In some instances a high concentration could be discovered during the data audit process. In either situation, the QAS will initiate a NAAQS exceedance memoranda. A standard form is used to identify if the data exceeding the NAAQS is of a valid nature. The exceedance verification form identifies results of specific checks preceding and subsequent to the exceedance event. If a check on both sides of the NAAQS exceedance are considered valid, then that data is considered valid provided that no intervening null codes between the checks invalidates the data. If any checks indicate an issue, the data may be suspect. The gas checks may be quarterly QAS PE audits or AMS zero, span, and QC one point checks. In some situations, this may entail a special QA audit after the exceedance to verify analyzer performance and data validity. Any invalid or missing data may be documented in the comments portion of the exceedance form.

The QAS chief and one QAS environmental manager reviews various AMP reports, such as AMP251, AMP256, and AMP350 that are generated quarterly from AQS and reviewed for any data that requires further analysis. The QAS has the authority to have data rechecked and if needed, invalidating additional data.

Section 24: Reconciliation with Data Quality Objectives

The data quality objectives and intended uses for the gas pollutant data are discussed in Section 7 of this QAPP. The main purpose of this data is to show compliance with the U.S. EPA NAAQS and to measure air pollutant concentrations that may be of concern for public health concerns and public welfare considerations. Section 7 of this QAPP also lists the measurement quality objectives, which were established to provide the expected data quality that users need.

It is the role of the QAPP to establish procedures to control measurement uncertainty to an appropriate level in order to achieve the objectives for which monitoring data are collected. As long as guidelines and any TSOPs/SOPs governing the measurement process are followed and all measurement quality objectives listed in this QAPP are met, it will be recognized that the DQOs can be achieved. However, there is always a chance that exceptional field events may negatively affect the performance of the monitoring station. Therefore, it is important to reconcile the monitoring data with the DQOs to evaluate whether the data set is adequate for its intended use. This involves reviewing routine data, such as the monthly verification and

validation reviews described in section 23 of this QAPP, and the results of 1-point quality control checks.

On a quarterly basis, the performance of the monitoring network will be evaluated by reviewing the data quality statistics (precision, bias and completeness) of the QA/QC data set and comparing the results to the monitoring project goals. Data quality assessment statistics are taken from the AQS AMP450 Report, Quick-look Report, the AQS AMP430 Report, Data Completeness, and the AQS AMP256 Report, QA Data Quality Indicator Report. The AMP450 Report provides summary statistics on the criteria pollutant data collected. The AMP430 Report provides a status of the quantity of criteria pollutant collected. The AMP256 Report provides a status of the QA/QC activities. Unacceptable performance for any of the DQO goals does not automatically indicate that the data set cannot be used for its intended purpose, i.e. the support of the decision process for a NAAQS. However, the impact on the confidence with which the data set can be used for its intended purpose in the decision process will have to be reviewed and communicated. This is done in the quarterly reports generated by the QAS environmental manager and QAS chief. Any anomalies are reported to the AMS(s) and ATS section chiefs and the AMB chief. The reports will identify the point(s) the data failed to meet DQOs and at what point in time, after corrective action, the data again meets DQOs. The corresponding data will be flagged and commented, and all supporting documentation will be included in the report.

The performance of the monitoring network for the previous year's data (January 1 to December 31) is evaluated for the annual Data Certification Package, which is due to the U.S. EPA by May 1st. The AQS AMP600 Report, Certification Report, is used to evaluate the performance of the network as to its attaining the Data Quality Objectives. The AMP600 report provides summary statistics on QA/QC activities and on collected data from each monitor. This report also provides a summary evaluation of monitoring network performance by flagging data collection and QA/QC activities as acceptable/green, warning/yellow or recommend N/red. Normally by this time any issues or concerns have already been dealt with and sufficient documentation is available. The annual certification letter will provide a short summary to document data collection or QA/QC activities flagged as warning (yellow) or red (recommend N).